Proceedings of the Iowa Academy of Science

Volume 59 | Annual Issue

Article 37

1952

An Aftonian Plant Locality in Lee County, Iowa

L. R. Wilson

University of Massachusetts

An Aftonian Plant Locality in Lee County, Iowa

By L. R. Wilson

Organic remains in glacial drifts and interglacial deposits are relatively abundant in Iowa and serve as valuable aids for the resolution of certain Pleistocene problems. The existence of fossils in the glacial deposits was early recognized and became one of the criteria for the separation of drift sheets (McGee, 1878), In 1895 T. C. Chamberlain noted the presence of peat separating two tills in the Afton Junction-Thayer region of Union County, Iowa. The name Aftonian was applied in connection with these interglacial deposits and has become the established designation of the oldest recognized interglacial stage in North America.

Comparatively few of the Aftonian plant remains have been critically studied. Most of the earlier discoveries were of wood and mosses, and their notation was for the most part incidental to the geological studies in hand though their importance as indices was appreciated. In recent years plant remains have received greater attention and in Iowa several detailed Aftonian studies have been made. In 1942 Steere published a comprehensive study of the Aftonian mosses of Iowa. With the advent of fossil spore and pollen work another tool has been added to paleontology. In 1940 Wilson and Kosanke reported the analysis of an Aftonian peat deposit in Tama County, and in 1941 Lane published the analysis of five other deposits. One of these is the well known "Oelwein cut" near Oelwein, Fayette County. Two are located near Denison, Crawford County and two others are in Union County near Thayer and Afton.

In 1916, George F. Kay found the site of the Aftonian remains described here, and in 1935, the writer in company with Dr. Alfred Meyer made several detailed collections of wood and their associated soils. The section then exposed was essentially the same as described hy Kay and Apfel in 1929. The location is in a small gully west of the railroad track in Washington Township, Section 28, T. 68 N., R. 4 W. In their description of the deposit Kay and Apfel (l.c., pp. 150-151) state: "Here is exposed the transition zone between the oxidized and unleached Kansan till and the unoxidized and unleached Kansan till, which is here about fifteen feet thick. Near the base of the unleached and unoxidized Kansan till there is much carbonaceous material, beneath which is a zone a few feet thick of leached sands and silts, the upper part of which is very carbonaceous. Included in the sands and silts are sticks and logs, some of which have a diameter of nearly six inches. The leached sands and silts which are interpreted to be Aftonian in age are in marked contrast to the overlying leached carbonaceous Kansan till. Beneath the Aftonian leached sands and silts there is unoxidized and unleached till."

Numerous sections of logs, branches, and fragments of wood were collected from the Aftonian layer and from several inches above in the Kansan till along the gully walls. Samples were collected from the upper two inches of carbonaceous interglacial soil, and from two inches below that level. Silt samples from the base of the Kansan till were also collected.

The woods were dried and preserved until prepared for study. All wood samples have proved to be of two genera elm (*Ulmus*) and spruce (*Picea*). When collected the wood was spongy and thoroughly saturated by ground water. After drying, some samples showed a high degree of limonite impregnation and a number of specimens became covered with minute selenite crystals and aggregates. This was especially true of the elm wood which is considerably more porous than spruce. Much of the latter is dense, almost black and heavier than recent wood of that genus. In preparation for study, cubes approximating one inch were cut from the dried samples and boiled in water until they sank. Many of the samples became too spongy to be cut with a wood microtome and were placed in 95% alcohol until hardened. Sections ranging from five to twenty microns were then cut with the wood microtome and mounted in Diaphane on microscope slides. The silts and carbonaceous materials were boiled in a 15% solution of potassium hydroxide, diluted with distilled water and then passed through a one millimeter mesh screen. The material left on the screen was examined for identifiable plant parts. The sediment that passed through the screen was centrifuged and microscope slides made of a portion of the residue. The remaining residue was boiled in 52% hydrofluoric acid to remove the silica. This residue was washed and concentrated and also mounted on microscope slides. Diaphane proved to be the most satisfactory mounting material.

The screenings from the silts proved to be disappointingly barren of identifiable tissues. Fragments of wood and a few twigs constituted nearly all of the fossils. The most important discovery from the screenings was a single plum stone. This compares favorably with the common wild plum (*Prunus americana*).

Fossil Wood

The wood samples show a wide range of degradation. The photomicrographs in Plate 1 illustrate the best preservation found. Most of the woody tissues show the loss of lignin and much distortion. The later is apparently due to compression by the overburden during and after the Kansan glacial stage. Nearly all of the logs are distinctly flattened. Of the two species of wood found, elm constitutes about one fourth of the samples collected.

The species of elm can not be identified from the fossil wood. The largest elm log found is five inches in diameter and has seventy-nine annual rings of width nearly comparable with those of present-day elm in Iowa. The large spring wood vessels contain some tyloses in various stages of degradation and several of these are illustrated in Figure 2 of Plate 1. The summer wood appears to have suffered the greatest degradation and collapse. In the radial sections numerous black particles, possibly limonite, are found adhering to the cell walls. The pits of the vessels are often completely lacking and the parenchyma shows partial maceration. In the tangential sections the multiseriate rays appear to have suffered the greatest degradation.

The spruce wood may be of white spruce (*Picea glauca*) since only pollen of that species was found in the interglacial silts. The largest spruce log measures four inches in diameter and contains approximately one hundred thirty-six annual rings. The growth rings of several logs are exceedingly narrow, similar to those of spruce trees now growing at high altitudes or near the tree line in Canada. Probably the most significant feature about the spruce wood is its heavy dry weight and hardness. At first it would appear that the weight and hardness was due to mineralization, but thin sections (Plate 1, Figs. 1, 3, 5) show that little or no mineralization has taken place. The resinous nature and compact cells probably accounts for the heavy character of the wood. The spruce wood tissues are better preserved than the elm, but degradation is noted in the radial sections. In most tracheids the bordered pits are nearly destroyed and they have completely disappeared from many tracheids leaving circular voids. Some of the bordered pits isolated from the tracheids appear in the residues associated with the spores and pollen.

The Microfossils

Only the top inch or two of the Aftonian soil is carbonaceous and contains microfossils. The silt below, and that from the lowest overlying Kansan till, are barren. The microfossils observed in

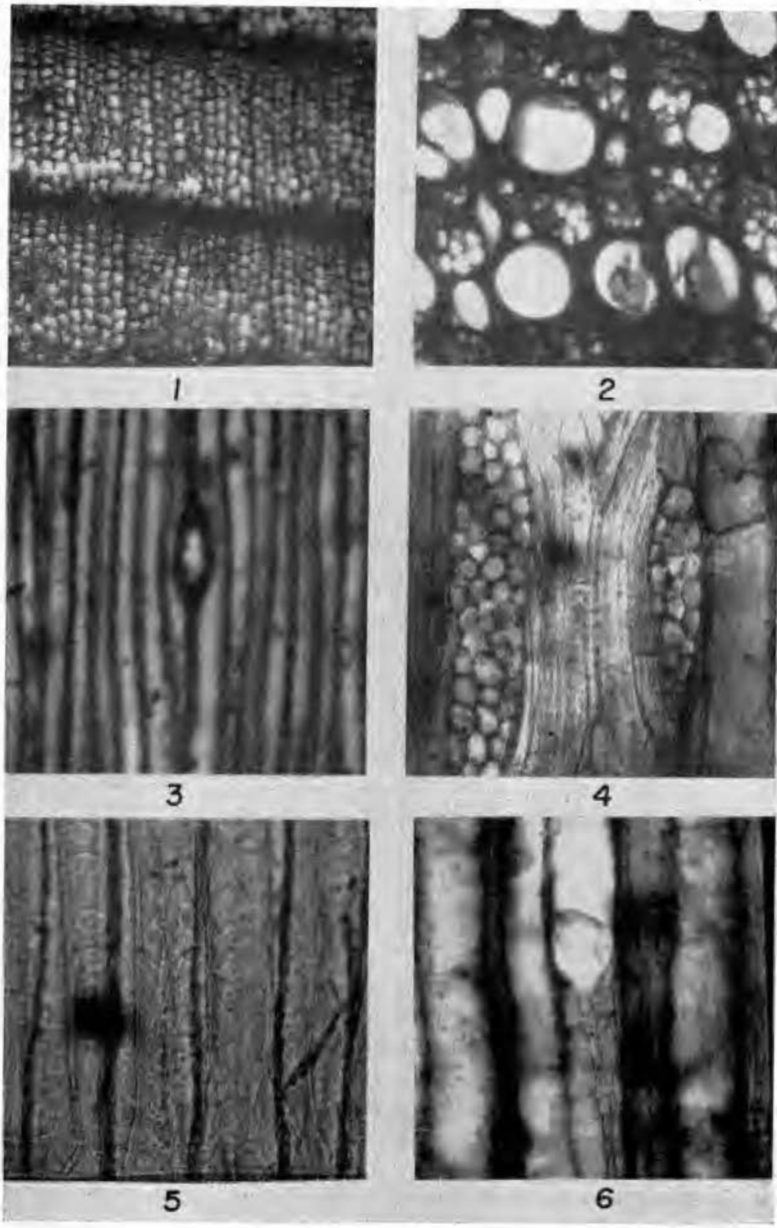

PLATE I

Photomicrographs of Aftonian Wood

Figures 1, 5. Spruce (*Picea*) cross section showing partial degradation of the trachieds.

Figure 2. Elm (*Ulmus*) cross section showing ring porous wood with two vessels containing tyloses.

Figure 3. Spruce tangential section showing uniseriate rays, fusiform ray with resin duct and trachieds with bordered pits in cross section.

Figure 4. Elm tangential section showing unstoried multiseriate rays, parenchyma and vessels.

Figure 5. Spruce radial section showing single rows of bordered pits.

Figure 6. Elm radial section showing vessels and minute black particles of mineral on the walls.

the interglacial soil consist of vegetable fragments, mostly wood tissues, a few moss and grass leaf tissues, fungus, moss and fern spores, conifer and angiosperm pollen, egg cases of mites, and chiton of arthropods. Though there is a wide variety of fossils they are, except for the wood fragments and fungus spores, scarce and very poorly preserved. The sediment in which the microfossils were preserved was probably a swamp forest soil with little organic development upon its surface. This is suggested after a microscopic comparison was made of the silts and modern forest soils. In such an environment fungus spores are usually more abundant than other spores or the pollen grains.

The fungus spores constitute 54% of the spore and pollen population. The identification of fungus spores to their natural groups is frequently not possible since many groups have similar form. However, two types in the deposit are noteworthy for they have been observed before in an early Pleitocene deposit in Minnesota described by Rosendahl (1943). Several specimens were found of the peltate perithecia of *Trichothyrites* and numerous vesicles of *Rhizophagites.* The members of the genus *Trichothyrites* are frequently parasitic fungi on conifer needles. Approximately six different types of fungus spores have been observed.

Moss spores belonging to *Sphagnum* are rare and none of the moss "leaf" tissues found belong to that genus. The latter are too fragmentary to be identified to genus.

The fern spores may belong to *Asplenium,* a genus containing several moist woodland fern species.

Picea (spruce) and *Pinus* (pine) are the only conifer genera represented. The spruce pollen is *Picea glauca* (white spruce) but the pine pollen grains are too poorly preserved to make more than generic identification. A population count of tree pollen showed spruce constitutes 50%, pine 36%, *Carya* (hickory) 7% and *Quercus* (oak) 7%.

Below in Table 1 is a percentage summary of relative abundance displayed by various plant microfossils.

Table 1

Total spore and pollen population expressed in percent

Fungi	54	Gramineae	13
Moss	1	*Quercus*	1
Polypodiaciae	13	*Carya*	1
Picae	7	Compositae	3
Pinus	5	Unknowns	2

Proceedings of the Iowa Academy of Science, Vol. 59 [1952], No. 1, Art. 37

Several mite egg cases and arthropod chiton fragments are also present in the sediments, but cannot be identified because of their incomplete nature.

Paleoecology of the Lee County Deposit

An evaluation of the deposit can be reached if a true interpretation is made of the fossils and the information supplied by the soils underlying the organic remains. Kay and Apfel (1929), have noted that beneath the carbonaceous material there is a zone, a few feet thick, of leached sands and silts. These are the soils upon which the forest grew. The extent of leaching would suggest a considerable period of interglacial time. However, the organisms now fossilized must be interpreted as having existed for but a short while just prior to their burial under the advancing Kansan ice. No evidences of impounded water and peat formation were found. In modern woodland environments only the organisms having lived within relatively recent years are sufficiently undecayed to be recognizable. All earlier generations of plants and animals have decayed and entered into the soil complex and are, therefore, unrecognizable as specific entities. Partly upon this evidence it is concluded that the organic remains represent only a short time near the end of the Aftonian interglacial stage.

The wood fossils suggest two unlike forest communities. The most abundant wood found is spruce and that genus suggests a northern climate, while the elm wood infers more southern mesophytic conditions. The two genera do grow in association with each other in Minnesota and southern Canada but neither are at their best development where their ranges overlap. The narrow width of many spruce growth rings is suggestive of unfavorable conditions while those of the elm are normal for a climate like that of Minnesota. One elm wood sample revealed many rootlets of foreign plants growing through the tissues. This may be interpreted as occurring after the elm log had fallen in the forest, was partially decayed and covered by mosses and herbaceous plants as is a frequent occurrence in recent woodlands.

The general condition of the fossil spores and pollen is very poor, only fungus spores, and conifer pollen show fair preservation. Fungus spores and certain conifer pollen are among the most resistant of that type of organic remains. This differential in preservation must be given consideration in the evaluation of a plant community such as the present. The few pollen grains of oak, hickory, composites and others suggest a forest considerably more mesophytic than the spruce pollen would suggest even though the later occurs in greater abundance. The relatively high percentages of grass pollen and fern spores may or may not be indicative of mesic conditions since these plants do occur associated with both warm and cold climate forests.

In summarizing the ecological aspect of the Lee County deposit it appears probable that near the close of the Aftonian interglacial stage there existed the remnants of a northern mesophytic forest with elements of the more northern spruce forest. As the Kansan ice advanced the spruce may have become more important on the upland and only in sheltered valleys did any of the hardwood trees persist. The Lee County deposit may represent the accumulation in a sheltered valley. When the ice overwhelmed the region some of the trees were incorporated in the Kansan till while the old forest floor was preserved without great deformation.

Relationship to Other Aftonian Deposits

A consideration of Aftonian time and its many organic deposits raises many questions. These involve the length of the interglacial stage, its climate, biota, and regional physiography. Before correlation of the organic deposits can be made and their relationship can be fully appreciated much careful work is still to be completed.

Various estimates have been given for the duration of the Pleistocene and its stages, but only the more recent phases can be determined with the accuracy afforded by the Carbon-14 technique. Estimates of older drifts and interglacial deposits are based upon such criteria as erosion of the drifts during their surface exposure, their leaching, extent of cutting of special gorges, retreat of falls, beach features cut by glacial lake waters, decomposition of boulders, oxidation of the drift and others.

That the Aftonian interglacial stage was of long duration is shown by evidence presented by Kay and Apfel (1929). They point out that there is an average of nine feet of gumbotil on the Nebraskan drift, that in some places the Nebraskan drift was completely eroded away, and that in northeast Iowa valleys were cut through the drift and four hundred feet into the underlying bedrock. Leverett (1930) states that the Nebraskan drift appears to be about one million years old, and Kay (1931) estimates the duration of the Aftonian stage as 200,000 years.

The fossils ascribed to Aftonian interglacial time present several interesting problems concerning their ages. Baker (1920) in a review of the Aftonian biota listed fourteen species of plants and seventy-five species of animals. The latter consist of fifty species of mollusks, twenty-five species of vertebrates and an unnumbered

Table 2

List of fossil plants reported from the Aftonian of Iowa.

THALLOPHYTA

Rizophagites sp., vesicles (16)*
Trichothyrites sp., perithecia (16)
Fungi spp., spores (16)

BRYOPHYTA

Sphagnum squarrosum Crome (14)
S. acutifolium Ehrh. (14)
S. cymbifolium Crome (14)
Sphagnum sp. spores (16), (17)
Fissidens sp. (14)
Dicranum Bergeri Bland. (14)
Philonotis sp. (14)
Autacomnium palustre (Web. & Mohr.) Schwaegr. (14)
Fontinalis spp. (14)
Anomadon attennatus (Hedw.) Huber. (14)
Thuidium delicatulum (Hedw.) Mitt. (14)
Calliergon stramineum (Brid.) Kindb. (14)
C. cordifolium (Hedw.) Kindb. (14)
C. Richardsonii (Mitt.) Kindb. (6), (14)
C. giganteum (Schimp.) Kindb. (14)
C. aftonianum Steere (14)
C. Hansonae Steere (14)
C. Kayianum Steere (14)
Drepanocladus aduncus (Hedw.) Warnst. (11), (14)
D. fluitans (Hedw.) Monkem. (2), (8), (12), (13), (14)
D. fluitans, var. *glaciale* Holz. (6)
D. fluitans, var. *Jeanbernati* (Ren.) Moenkem. (5)
D. exannulatus (Grumb.) Warnst. (14)
Drepanocladus revolvens (C. Mull.) Warnst. (6), (14)
D. apiculatus Steere (14)
Scorpidium scorpioides (Hedw.) Limpr. (14)
Amblystegium Juratzkanum Schimp. (14)
Leptodictyum riparium (Hedw.) Warnst. (14)
Campylium stellatum (Hedw.) Lang and C. Jens. (14)
Camptothecium nitens (Hedw.) Schimp. (12), (13), (14)
C. Woldenii Grout. (4), (14)
Hylocomium splendens (Hedw.) Bry. Eur. (14)
Polytrichum strictum Banks. (14)

PTERIDOPHYTA

Polypodiaceae, rootstalks (12), spores (16)

SPERMATOPHYTA

Gymnospermae
Abies balsamea (L.) Mill., pollen (17)
A. sp., pollen (7)
Tsuga sp., pollen (7)
Picea mariana (Mill.) BSP., wood (1), (9), cones (1), pollen (17)

*References to literature containing reported plant fossils. (1) Bain, 1896. (2) Beyer, 1897. (3) Calvin, 1898. (4) Grout, 1917. (5) Grout, 1930. (6) Holzinger, 1903. (7) Lane, 1941. (8) MacBride, 1897. (9) MacBride, 1907. (10) McGee, 1891. (11) Pratt, 1876. (12) Savage, 1904. (13) Savage, 1905. (14) Steere, 1941. (15) Webster, 1888. (16) Wilson, this paper, (17) Wilson and Kosanke, 1940.

P. glauca (Moench.) Voss., wood (9), pollen (16), (17)
P. sp., leaves and twigs (12), cones (?) (12), pollen (7)
Larix laricina (Du Roi) Koch., wood (3), (8), pollen (7)
Pinus Strobus L. or *P. resinosa* Ait., pollen (17)
P. Banksiana Lamb., pollen (17)
Thuja sp. (?), wood (10)
Juniperus sp. (?), wood (10)

Angiospermae

Typha sp., pollen (7)
Sparganium sp., pollen (7)
Potomogeton sp., pollen (7)
Gramineae, leaves (12), (15) pollen (7), (16), (17)
Cyperaceae, pollen (7), (17)
Juncus sp., pollen (7)
Salix sp., pollen (7)
Populus sp. (?), leaf fragments (12)
Juglans sp., pollen (7)
Carya sp., pollen (7), (16)
Betuleae, pollen (7)
Betula sp., pollen (17)
Fagus sp., pollen (7)
Quercus sp., pollen (7), (16), (17)
Ulmus sp., wood (16)
Celtis sp., pollen (7)
Rumex sp., pollen (7)
Chenopodiaceae — Amaranthaceae, pollen (7)
Platanus sp., pollen (7)
Prunus americana Marsh., fruit stone (16)
Acer sp., pollen (7), (17)
Tilia sp., pollen (7), (17)
Fraxinus sp., pollen (7)
Compositae, pollen (7), (16), (17)

---

quantity of insect wings. Twenty-three of the vertebrate species are now extinct. Hay (1912), has referred the vertebrate fauna to the Aftonian, but Kay (1931), states that because of the uncertainty of the stratigraphic position in which the fossils were found they may be more truly considered contemporaneous with the Nebraskan ice. Certainly the variety of species of horses, camels, *Megalonyx, Mylodon, Platygonus* and others strongly suggest a Pliocene affinity. With the exception of the new species of mosses described by Holzinger (1903), Grout (1917) and Steere (1941), none of the plants from the Iowa Aftonian are known to be extinct. It should be pointed out, however, that only small leafy plants like mosses are to be found in complete enough condition to allow adequate comparison with modern species. Wood, spores and pollen appear to be more conservative in their evolution than leaves, consequently, extinct species are less likely to be recognized among those fossils.

Below is a list of the plant fossils recovered from Aftonian deposits in Iowa. Further study will undoubtedly alter the list.

Some of the species reported may not be correctly identified. It is unfortunate that most of the earlier collected materials have been lost so that reexamination is impossible. The wood species reported in the early publications were not always studied critically with the microscope and cannot be relied upon being as reported. Larch, black spruce, and white spruce are among the most commonly misidentified. The two latter species according to Brown, *et al* (1949) cannot be differentiated on wood anatomy.

The exact age relations of many extinct species, or any of the Aftonian organic-bearing deposits, cannot be stated with certainty. If the Aftonian interglacial time was of the magnitude of 200,000 years, few of the earlier organic remains would have survived the soil weathering processes suggested by the depth of the gumbotil unless they were buried under very special conditions. Where the physiography permitted the impounding of water, silts and peats might accumulate and fossil remains could occur. Climatic changes toward a cool, moist phase would enhance their forming, but all such deposits need not, and apparently were not exactly contemporaneous. An examination of the fossil pollen spectra of Wilson and Kosanke (1940) and of Lane (1941) might suggest difference in ages at least of some of the deposits for they are distinctly unlike.

In the Denison Peat, Crawford County, Series "A", described by Lane (l.c., fig. 2.) there appears to be a very long period of Aftonian time recorded. Evidence, also noted by Lane, that would support this statement are the major vegetational changes that occurred during the formation of the deposit. In the deposit between the forty and thirty inch levels of the section there is a total absence of pollen. This portion might prove to represent a slow accumulation of silt in a prairie environment unfavorable for pollen preservation, or another possibility is that the silt was washed into the depression so rapidly that little or no pollen was trapped. The abruptness with which the fossil pollen disappears at the forty inch level and reappears above at the twenty-eight inch level may be suggestive of some physiographic event rather than climatic change. Lane has noted important grassland and deciduous elements in the Denison deposits and postulates climatic conditions similar to the present for western Iowa. He further points out a markedly different pollen spectrum seventy-five miles southeast of Denison in Union County. There, spruce and pine forests appear to have dominated the region. In the vicinity of Oelwein, Fayette County, in eastern Iowa there is a pollen record somewhat similar to that in Union County. In the Belle Plaine, Tama County deposit (Wilson and Kosanke, 1940) there is evidence in the middle levels of a northern deciduous forest which separated two intervals of conifer dominance. Concerning the age relations of the Union and Crawford deposits, Lane states "It seems doubtful if the peat series here [Union County] can represent the same time period as that in Crawford County. It is not likely that conifers would remain dominant here throughout the interglacial period while, only seventy-five miles to the northwest [Denison], a prairie vegetation flourished." He further states that "while it is not absolutely impossible, on the evidence, that coniferous forests remained here throughout the Aftonian it seems more probable that a prairie vegetation was developed either preceeding this peat deposit or following the cessation of the peat record." In an attempt to postulate the age relations of the several pollen spectra studied by him, Lane considers the Dodge township deposit of Union County as the oldest and the Denison and Rickets deposits of Crawford County next in age and they are separated from the Dodge township deposit by a hiatus of unknown magnitude. The Oelwein deposit of Fayette County and the Thayer deposit of Union County he considers were formed during the last part of the interglacial stage, but he also cites the possibility that they may be nearly contemporaneous with the Dodge township deposit. It is evident from the foregoing statements that no definite conclusions as to age relations are established. Further studies are indeed necessary to resolve the problem.

The apparent abundance of coniferous, deciduous and grass pollen at the same levels in the deposits of Aftonian age appears incongruous but a similar situation is to be found in the modern peats in western Ontario and eastern Manitoba, Canada. The similarity of pollen spectra in some of these modern peats near the prairie border in Canada to the Aftonian pollen spectra of Iowa may be suggestive of the vegetative cover in Iowa during the first interglacial stage. It is not infrequent to find as great differences in pollen spectra in western Ontario and eastern Manitoba across an east-west distance of fifty to one hundred miles as one finds in the Aftonian deposits of Iowa. Further Aftonian studies may bear out this observation and show that all of the Aftonian deposits were nearly synchronous and that they were formed late in Aftonian time.

Various statements concerning Aftonian climate are to be found in the literature. Shimek (1909), describing the geology of Harrison and Monona counties in western Iowa, states concerning Aftonian conditions, "The presence of the land shells in the Aftonian is especially suggestive, for land species probably suffer much more from climatic changes than aquatic forms. Moreover, they are herbivorous and require a relatively rich flora for shelter. Their presence seems to prove the proximity to the Aftonian streams of plant covered land areas similar to those which now prevail in the region under discussion, and a climate not materially different from that of Iowa today, at least as far as temperature is concerned." Baker (1920), states "the Aftonian was a time of luxuriant forests, the climate was moist and the winters were not too severe for animals as the elephant, horse and peccary. The type of mollusks indicate a climate not essentially different from that of today." Further he states "a study of the entire biota reveals two types of life (1) a warm temperate, in which the naids and other mollusks and the larger part of the mammals lived, and (2) a cold temperate climate in which a boreal flora flourished." Steere (1941), after critically studying the Aftonian moss flora, wrote concerning the climate, "judged by the abundant moss material which has been discovered in its deposits, was much colder and wetter than at present, with a climate like that now existing five hundred to a thousand miles farther north."

The climate of the Aftonian, or any part of geological time, must be judged on the basis of physical phenomena or by the organic remains preserved at a particular time. The preservation is dependent upon numerous factors related to physiographic conditions, climate and the nature of the organisms. Physiographic conditions are frequently governed by climate and during interglacial times it would seem that cool wet periods would be more favorable for preservation than warm dry periods. This may be especially true where the burial sites were of very limited extent for they would suffer greater weathering. Large organisms are less apt to burial than minute forms, also they are usually more subject to decay. The larger the organisms, the faster must be the burial for preservation, and physiographic conditions favoring entombment are relatively less frequent. Minute organisms may be preserved in sediments of very restricted extent and where the deposition is slow the time interval is proportionally greater. For these reasons microfossils tend to be better than megafossils in studying the details of geological time as short as the interglacial stage. In recent years the study of fossil spores and pollen has been developed into an important paleoecologic and stratigraphic science. These fossils are minute, preserve well in many sediments, occur frequently in great numbers, have a high specificity, are good ecologic indices and can be treated statistically.

The results of Aftonian spore and pollen studies are helpful in bridging the various other conclusions concerning the climate of this interglacial stage. Whereas fossil bones, mollusks, wood, cones and mosses occur frequently in the Aftonian deposits they represent only certain horizons and do not extend vertically very far through the deposits. Conditions were not always as favorable for their preservation as for that of microfossils. Spore and pollen spectra present evidence that in Iowa, boreal conifer forests were succeeded by temperate deciduous forests, prairie communities, and finally by a mixture of boreal coniferous and deciduous forest species. Though the spore and pollen record conceivably spans thousands of years it does not appear probable, as noted above, that any one deposit records the entire vegetational history of the Aftonian stage and there is a possibility that no record is available for much of it. It appears reasonable to suppose that during the earliest part of Aftonian time the climate was severe, verging on arctic, and that it was subsequently succeeded by boreal and more temperate climatic phases, finally there was a return to boreal conditions towards the end of the stage. Lane (l.c.) states there is a possibility of a late interglacial amelioration of climate in the Aftonian, and cites similar observations in Europe by Jessen and Milthers (1928), Premik and Piech (1932), and Szafer (1931). A complete Aftonian climatic sequence for Iowa as suggested above, however, has not been demonstrated. Until a deposit containing microfossils that can be shown to have persisted throughout the Aftonian is found, or that the deposits already studied represent the entire time interval, or that they can be related in a sequence that would span the Aftonian, no definite statement can be made. The total climate of the Aftonian is not a settled problem.

Summary

1. A plant bearing deposit of late Aftonian age is described from Washington township, Lee County, Iowa.
2. The plant remains consist of elm, pine and spruce wood, a plum stone, leaf fragments, spores and pollen.
3. The ecology of the late Aftonian vegetation appears comparable to that now existing in north central Minnesota or southern Canada.
4. Studies of other Aftonian plant deposits are discussed and it is suggested that none of these probably span the total time of the interval.
5. There is reason to believe that there were climatic fluctuations during the Aftonian stage.

The author wishes to express his appreciation to Dr. Alfred Meyer of Coe College for his aid in making the plant collections, to Professor Albert Nelson who identified the selenite incrusting the fossil woods, and to Dr. Robert V. Drexler for reading the manuscript.

Literature Cited

Bain, H. Foster. 1896. Geology of Washington County. Iowa Geol. Surv. 5: 153-154.

Baker, F. C. 1920. The Life of the Pleistocene or Glacial Period. Univ. Ill. Bull. 17: i-xiv, 1-476.

Beyer, S. W. 1897. Evidence of a Sub-Aftonian Till Sheet in Northeastern Iowa. Proc. Iowa Acad. Sci. 4: 58-62.

Brown, H. P. et al. 1949. Textbook of Wood Technology. Vol. I. McGraw-Hill Book Co., Inc.

Calvin, Samuel. 1898. Geology of Buchanan County. Iowa Geol. Surv. 8: 240-241.

Chamberlain, T. C. 1895. The Classification of American Glacial Deposits. Jour. of Geol. 3: 270-277.

Grout, A. J. 1917. A fossil *Camptothecium.* Bryologist 20: 9.

.... 1930. A fossil form of *Drepanocladus fluitans Jeanbernati* (Ren.) Moenken. Bryologist 33: 33.

Hay, O. P. 1924. The Pleistocene of the Middle Region of North America and its Vertebrate Animals. Carnegie Inst. Washington Pub. No. 322A. 285 pp.

Holzinger, J. M. 1903. On Some Fossil Mosses. Bryologist 6: 93-94.

Jessen, K. and V. Milthers. 1928. Stratigraphical and Paleontological Studies of Interglacial Freshwater Deposits of Jutland and Northwest Germany. Danm. Geol. Unders, Ser. II, No. 48, pp. 1-379.

Kay, George F. 1931. Classification and duration of the Pleistocene Period. Geol. Soc. Amer. Bull. 42: 425-466.

.... and Earl T. Apfel. 1929. The Pre-Illinoian Pleistocene Geology of Iowa. Iowa Geol. Surv., 34: 1-304.

Lane, Geo. H. 1941. Pollen Analysis of Interglacial Peats of Iowa. Iowa Geol. Surv. 37: 233-266.

Leverett, F. 1930. Relative length of the Pleistocene glacial and Interglacial Stages. Science, N. S. 72: 193-195.

.... 1932. Quaternary geology of Minnesota and Parts of Adjacent States. U. S. G. S. Prof. Paper. 161: 1-149.

MacBride, T. H. 1897. A Pre-Kansan Peat Bed. Proc. Iowa Acad. Sci. 4: 64-66.

.... 1907. On Certain Fossil Plant Remains in the Iowa Herbarium. Proc. Davenport Acad. Nat. Sci. 10: 153-162.

McGee, W. J. 1878. On the Relative Position of the Forest Bed and Associated Drift Formations in Northeastern Iowa. Amer. Jour. Sci. 3rd Ser. 15: 339-341.

.... 1891. The Pleistocene History of the Northeastern Iowa. U. S. G. S. 11th Ann. Rept. Part. 1. pp. 191-577.

Pratt, W. H. 1876. Reports on a Geological Examination of the Section of Bluffs Recently Exposed by the C. R. I. & P. R. R. Proc. Davenport Acad. Nat. Sci. 1: 96-99.

Premik, J. and K. Piech. 1932. Zur Kenntnis des Diluviums im Sud-Westlichen Mittlepolen Ann. de la Soc. Geol. de Pologne. 8(2): 1-132.

Rosendahl, C. O. 1943. Some Fossil Fungi from Minnesota. Bull. Torr. Bot. Club. 70: 126-138.

Savage, T. E. 1905. Geology of Fayette County. Iowa Geol. Surv. 15: 433-560.

Shimek, B. 1909. Geology of Harrison and Monona Counties. Iowa Geol. Surv. 25: 271-485.

Steere, William Campbell. 1941. Pleistocene Mosses From the Aftonian Interglacial Deposits of Iowa. Papers of the Mich. Acad. Sci., Arts and Lett. 27: 75-104.

Szafer, W. 1931. The Oldest Interglacial in Poland. Bull. Acad. Pol. Sci. et Lett. 1: 19-50.

Webster, Clement L. 1888. Notes on the Geology of Johnson County, Iowa. Amer. Nat. 22: 414-415.

Wilson, L. R. and R. M. Kosanke. 1940. The Microfossils in a Pre-Kansan Peat Deposit near Belle Plaine, Iowa. Torreya 40: 1-5.

DEPARTMENT OF GEOLOGY AND MINERALOGY
UNIVERSITY OF MASSACHUSETTS
AMHERST, MASSACHUSETTS